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(54) TUBE END PLUG

(71) We, GUY-RAYMOND ENGINEERING COMPANY LIMITED, a British Company of Rollesby Road, King's Lynn, Norfolk PE30 4LX England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a plug for closing the end of a circular or rectangular tube.

Steel tube is used to an increasing extent in many industries, for instance, in the manufacture of racking for agricultural and industrial purposes or in retail outlets and there has therefore been an increase in the demand for a plug for closing the end of a steel tube temporarily before the steel tube is made up into a finished product and also in the finished product itself.

Hitherto a plug for this purpose has normally comprised a hollow cross-section shank which is inserted into the end of the steel tube and a head which provides a circumferential abutment surface which limits insertion of the plug into the tube. In order to ensure that the shank of the plug is a friction fit in the tube the wall of the shank of the plug may be outwardly convex or the shank of the plug may be provided with a plurality of ribs which collapse slightly as the shank of the plug is inserted into the tube.

This type of plug has allowed little if any tolerance on the internal dimensions of the tube. This has meant that a range of plugs must be manufactured and stocked to fit every tube size with a consequent increase in the manufacturing and stock costs. This problem has become particularly acute recently because steel tube of a substantial cross-section, say four inches in diameter is now offered in a range of wall thicknesses. For every given wall thickness the internal dimensions of the tube are different and a different size of plug must be provided. Normal manufacturing tolerances add to the problem which has been further aggrevated by the change-over to a metric system of measurement. This has meant a substantial increase in the range of steel tube sizes which are now available.

In addition, cut steel tubes tend to have burrs around the cut edges which tend to impede the insertion of plugs and scratch the plug surface.

In order to meet these problems, we have designed a plug for closing the end of a steel tube which is provided with a sufficient tolerance that it can be securely mounted in steel tubes have a wide range of internal cross-sectional sizes. The plug of the present invention will not only take up normal manufacturing tolerances in the internal dimensions of a tube but can also be used in tubes of substantially different wall thicknesses and internal dimensions.

The invention provides a plug for closing the end of a tube, the plug comprising a hollow shank of constant diameter having a leading end, a head at the end of the shank opposite the leading end, an abutment surface on the head extending outwardly of the shank and facing the leading end and a plurality of flexible ribs projecting outwardly from the outer face of the shank, the axial thickness of each rib decreasing progressively towards its free end and wherein the ribs nearer the head are larger than those near the leading end so that the outline shape of the plug increases towards the head.

An important advantage of the plugs of the invention is that the ribs can be made sufficiently flexible to snap any burrs on the tube end being plugged.

The shank may for example be rectangular, square or circular in cross-section. If the shank is square or rect-

angular, each side of the shank preferably comprises a wall stiffened by a strut which extends radially inwardly of the shank from the centre of the side wall. In order to ensure that the ribs and each side wall of the shank can collapse as the shank is inserted into a tube, each rib is preferably interrupted along its length at a point approximately adjacent the position of the internal stiffening strut.

Preferably also, if the shank is rectangular each rib is progressively reduced adjacent the side edge or corner of the wall from which it projects. This ensures a minimum of interference and friction against the corners of the tube and also provides a gap between the plug and the wall of the tube at each corner of the tube which acts as a vent for gas or liquid to escape from the tube.

Where three or more ribs are provided on each side of the shank, the two ribs adjacent the head may project outwardly from the shank to a similar extent and to a greater extent than the rib or ribs adjacent the leading end of the shank.

Preferred forms of the present invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is an elevation partly in section of a plug according to the present invention;

Figure 2 is a plan view from below of the plug shown in Figure 1;

Figure 3 is a section showing a detail of the plug shown in Figure 1;

Figure 4 is an elevation partly in section and similar to Figure 1 but showing a plug which comprises a further embodiment of the present invention;

Figure 5 is a plan view from below of the plug of Figure 4;

Figure 6 is an elevation partly in section showing a plug which comprises yet a further embodiment of the present invention;

Figure 7 is a plan view from below of the plug shown in Figure 6;

Figure 8 is a plan view from below of a fourth embodiment;

Figure 9 is a cross-section on the line IX-IX of Figure 8;

Figure 10 is an elevation of a fifth embodiment and

Figures 11 and 12 are respectively a side elevation and a bottom plan view of a sixth embodiment.

In Figure 1 a plug is indicated generally at 10 which is formed from a synthetic plastics material such as polyethylene. The plug 10 is a unitary moulding manufactured by any conventional moulding technique.

In its finished form the plug 10 comprises a hollow tubular shank 11 which is square in cross-section and comprises four similar flat walls 12, 13, 14 and 15. The shank 11 is open at its leading end 16 and is closed at its other end by a head 17 which provides a circumferential abutment surface 18 extending around the periphery of the shank 11.

Four ribs 19, 20, 21 and 22 extend outwardly from the outer surface of each wall. The ribs on each wall are similar and only the ribs projecting outwardly from the wall 12 will be described in detail. Each rib extends across the full width of the wall 12 but is interrupted at the midpoint of the wall by a break 23 so as to comprise two similar halves 19, 19*a*, 20, 20*a* etc. Adjacent each end of the wall 12, the ribs are reduced or tapered so as to provide no interference adjacent the corners of the shank. In cross-section each rib is tapered and comprises an upper face 24 and a lower face 25. The upper face 24 is tapered at approximately 5° to a plane normal to the wall 12 and the lower face 25 is inclined at an angle of approximately 30°. The cross-sectional shape of each rib is designed to ensure that the rib will flex relatively easily as the shank of the plug is inserted into a tube.

The ribs 19 to 22 project outwardly from the wall 12 to an extent which increases towards the head 17, thus the rib 20 projects outwardly from the wall 12 to a greater extent than the rib 19 and the rib 21 projects outwardly to a greater extent than the rib 20. For reasons which will be explained below, the ribs 21 and 22 which are adjacent the head 17 project outwardly to the same extent. This can be seen best from the righthand side of Figure 1.

In order to stiffen and strengthen the walls of the shank 11, four stiffening struts 26, 27, 28 and 29 extend radially inwardly from the mid-point of the walls 12 to 15 respectively. It will be noted from Figure 2 that the interuption or break 23 in the ribs 19 to 22 occurs directly opposite the strut 26.

The plug 10 is used to close the end of a steel tube by inserting the shank 11 into the tube until the abutment surface 18 of the head 17 abuts the end of the tube. The shank 11 of the plug 10 will provide a secure friction fit in a tube having a cross-section lying anywhere between the dimension '*a*' and the dimension '*b*' shown in Figure 1. It will be seen that the dimension '*a*' is a distance slightly less than the maximum distance between the crests of the ribs 19 on opposite faces of the shank and the distance '*b*' is a distance slightly less than the maximum distance between the crests of the ribs 21 on opposite sides of the shank.

If the plug is used to close a tube of cross-

section '*a*' the ribs 19 provide an initial interference against the internal wall of the tube and centralise the plug in the tube. As the plug is driven home, the larger ribs 20, 21 and 22 are bent and deflected to provide a secure friction grip on the inside internal wall of the tube. If the plug is used to close a tube of cross-section closer to the dimension '*b*' the ribs 19 and 20 will not engage the wall of the tube but will serve to centralise the shank of the plug as it enters the tube. The ribs 21 and 22 will then engage the internal wall of the tube to provide a secure friction grip on the tube and retain the plug in position. Two ribs 21 and 22 are provided, of the same size adjacent the head to ensure that the plug is effectively secured in a tube of larger cross-section.

When the plug is used wth a smaller dimension tube, there is a tendency for the walls to bow inwardly because of the substantial interference between the larger ribs 21 and 22 and the wall of the tube. The struts 26 to 29 resist this tendency for the walls to bow and stiffen the walls in their area of maximum weakness. The interruption or break 23 in each of the ribs ensures that the ribs will bend and flex relatively easily when the plug is inserted in a relatively small tube. The tapered ends of the ribs ensure that there is minimum interference at the corners of the shank of the plug to facilitate insertion of the plug into the tube and render the ribs more easily bendable.

The tapered ends of the ribs also ensure that there is a gap between the shank and the tube wall at each of the internal corners of the tube. These four gaps act as vent channels for the escape of gas or liquid trapped in the tube. This is particularly important if the tube is subjected to temperature changes which can lead to pressure building up in the tube which would force the plug out of the tube if it was not vented.

It will be appreciated that the cross-sectional shape of the plug 10 can be varied to suit the cross-sectional shape of the tube and Figures 4 and 5 illustrate a plug 30 which is rectangular in cross-section and approximately twice as long as it is wide. The plug 30 is similar to the plug 10 and comprises a shank 31 having four walls 32, 33, 34 and 35, the walls 32 and 34 being twice the length of the walls 33 and 35. The shank is open at one end and is closed at the other end by a head 36 which forms an abutment surface 37.

Each wall 32 to 35 is provided with four ribs 38, 39, 40 and 41 which are similar in every respect to the ribs 19 to 22 of the plug 10. The longer walls 32 and 34 are strengthened by internal stiffening struts 42 and 43 respectively and the ribs 38 to 41 on the longer walls 32 and 34 are interrupted in the region adjacent the struts 42 and 43 by a break 44. The ribs on the shorter walls 33 and 35 are continuous and uninterrupted.

The plug 30 is used in the same manner as the plug 10 and closes the end of a tube having an internal cross-section lying between the area defined by the smaller ribs 38 and the area defined by the larger ribs 40, 41. In use, all of the ribs provide an inference, frictional engagement on a tube of relatively small cross-section and the ribs 40 and 41 provide an interference, frictional engagement on a tube of larger cross-section. The struts 42 and 43 stiffen the longer walls 32 and 34 and resist any tendency for these walls to bow while the break or interruption 44 in the ribs on the longer walls 32 and 34 ensures that the ribs will bend and deflect relatively easily when the shank of the plug is inserted into a tube of relatively small cross-section.

Figures 6 and 7 illustrate a plug 50 which comprises a further embodiment of the present invention and which is circular in cross-section.

The plug 50 comprises a hollow shank 51 which is circular in cross-section and a head 52 which is also circular in cross-section and which closes the end of the shank opposite to the leading end. The diameter of the head 52 is substantially greater than the outer diameter of the shank 51 so as to form an annular abutment surface 53 projecting outwardly from the shank and facing the leading end of the shank.

The wall of the shank 51 is provided with four ribs 54 to 57 which are similar to the ribs 19 to 22 of the plug 10 except that they extend continuously around the circular shank 51. The ribs 56 and 57 adjacent to the head 52 are of the same diameter, the rib 55 having a slightly smaller diameter than the rib 56 and the rib 54 having a slightly smaller diameter than the rib 55. Thus the diameter of the ribs increases from the leading end of the shank towards the head 52.

The four ribs 54 to 57 are interrupted at the same point around the circumference of the shank 51 so as to form a break or vent channel 58 extending through the ribs. The channel 58 acts as a vent channel and also increase the flexibility of the ribs and the shank wall allowing the side of the shank to collapse more readily.

The plug 50 is used in the same manner as the plug 10 and the plug 30 except that it is designed to close the end of a tube of circular cross-section.

The plug shown in Figures 8 and 9 is similar to that of Figures 1 to 3 except that is has on each side two continuous ribs 59, 60 which are of the same size and a smaller

interrupted rib 61 positioned nearest the leading end of the plug.

The plug shown in Figure 10 is also a square-section plug, having on each side two continuous ribs 62, 63 of equal size and a smaller continuous rib 64 nearest the leading end of the plug. This arrangement is particularly suitable for small plugs, which can be made without the internal strengthing struts 26-29.

The plug shown in Figures 11 and 12 is of rectangular cross-section and has on each of its major sides too continuous ribs 65 nearest the leading end of the shank and an interrupted rib 66 nearest the head end. The ribs on the minor sides are continuous. A rectangular strut 67 extends across the inside of the shank 31. The strut 67 is integral with the head 36 and extends to approximately half the depth of the shank 31.

It will be seen that we have provided a plug for closing the end of a tube which can be used in tubes of a wide range of internal cross-section while ensuring a secure frictional engagement within the tube. By providing progressively larger ribs on the external surfaces of the walls of the shank of the plug we have ensured that the shank is centralised as it enters the tube and we have minimised the risk of the plug being damaged through misalignment or tilting as it is forced home into the tube.

We have also reduced the risk of the plug jamming by interrupting the length of the ribs so as to increase their flexibility and in the case of a rectangular section plug by reducing the inteference between the shank of the plug and the wall of the tube to a minimum at the corners of the plug.

WHAT WE CLAIM IS:—

1. A plug for closing the end of a tube, the plug comprising a hollow shank of constant diameter having a leading end, a head at the end of the shank opposite the leading end, an abutment surface on the head extending outwardly of the shank and facing the leading end and a plurality of flexible ribs projecting outwardly from the outer face of the shank, the axial thickness of each rib decreasing progressively towards its free end and wherein the ribs nearer the head are larger than those near the leading end so that the outline shape of the plug increases towards the head.

2. A plus according to claim 1 wherein at least one of the ribs is interrupted.

3. A plug according to claim 1 or claim 2 which is of circular cross-section.

4. A plug according to claim 1 or claim 2 which is of rectangular cross-section, the shank comprising four side walls.

5. A plug according to claim 1 or claim 2 which is of square cross-section, the shank comprising four side walls.

6. A plug according to claim 4 or claim 5 having at least one internal strut to stiffen the sides of the shank.

7. A plug according to claim 6 wherein the or each strut extends towards the centre of the shank from the centre of a side wall.

8. A plug according to any one of claims 4 to 7 wherein the ribs on each side wall of the shank are interrupted at the centre of the side wall.

9. A plug according to any one of claims 4 to 7 having on at least two side walls at least one continuous rib and at least one interrupted rib.

10. A plug according to claim 9 having on each side wall at least one continuous rib nearest the head and at least one interrupted rib nearest the leading end of the shank.

11. A plug according to claim 10 having on at least two opposite side walls at least one interrupted rib nearest the head and at least one continuous rib nearest the leading end of the shank.

12. A plug according to any one of claims 4 to 11 wherein each rib is progressively reduced adjacent the side edge or corner of the wall of the shank from which it projects.

13. A plug according to any preceding claim which has three or more ribs or sets of ribs, the two ribs or sets of ribs nearest the head projecting outwardly from the shank to a similar extent and to a greater extent than the rib or ribs nearer the leading edge of the shank.

14. A plug according to any preceding claim wherein the ribs are of substantially triangular cross-section.

15. A plug according to claim 14 wherein each rib of triangular cross-section has an upper surface making an angle of approximately 50 to a plane perpendicular to the axis of the plug and a bottom surface making an angle of approximately 30° with the said planes.

16. A plug substantially as herein described with reference to, or as illustrated in, Figures 1-3, Figures 4 and 5, Figures 6 and 7, Figures 8 and 9, Figure 10 or Figures 11 and 12 of the accompanying drawings.

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1551855 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig.1

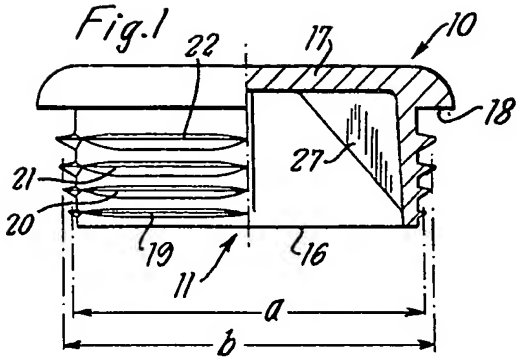


Fig.3

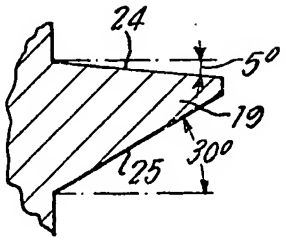
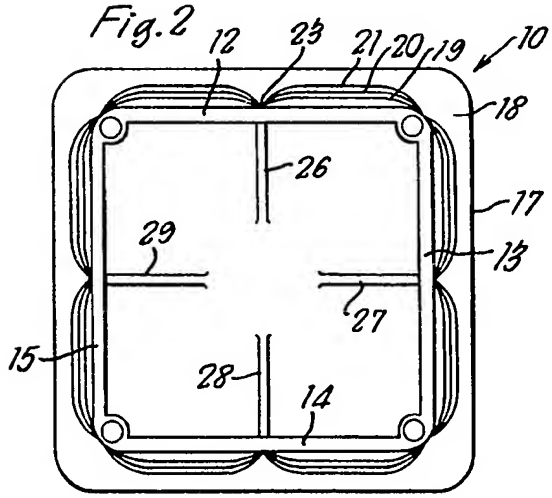


Fig.2



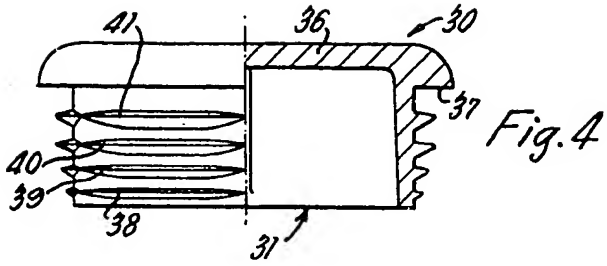


Fig.4

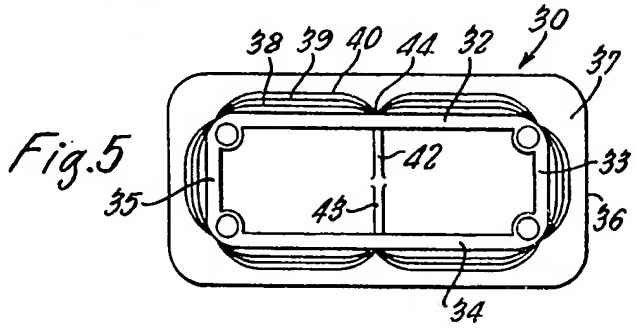


Fig.5

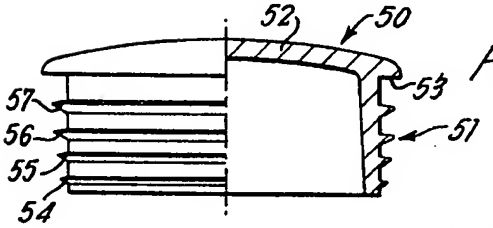


Fig.6

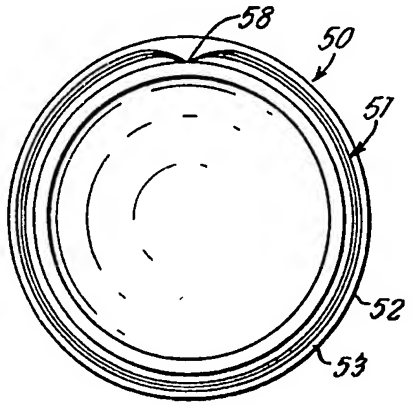


Fig.7

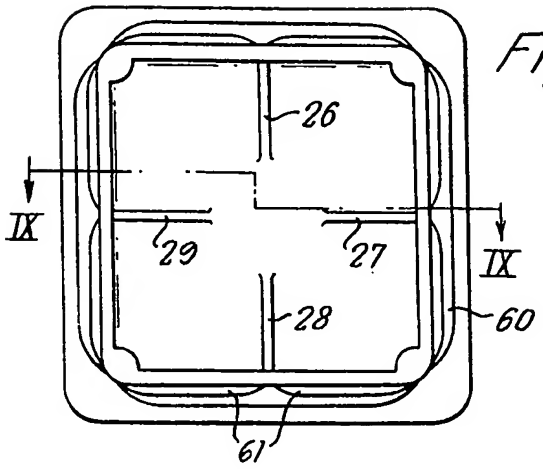
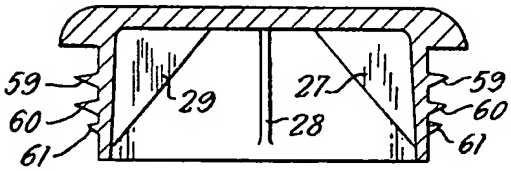


Fig. 8

Fig. 9



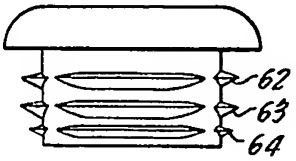


Fig. 10

Fig. 11

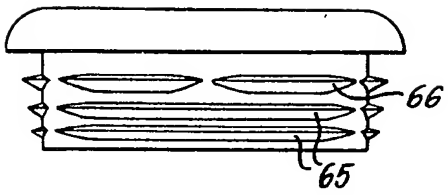


Fig. 12